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Ectocarpus siliculosus (Dillwyn) Lyngb. from Hopkins River Falls, Victoria - the first record of a freshwater brown alga in Australia

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ABSTRACT

Ectocarpus siliculosus was collected on 24 March 1995 at Hopkins River Falls, Victoria. (38°20'S, 142°37'E) This site is about 25 km from the river mouth at Warnambool and about 40 m above sea-level. It grows well and reproduces by plurilocular sporangia in laboratory culture at 5, 15 and 30% salinity, 15, 20 and 25°C and 10-30 µmol m^{-2} s^{-1} irradiance. This is a first record of a brown alga occurring in freshwater in the southern hemisphere.

Introduction

The brown marine algae are frequently associated with salt marshes and mangroves in Australia (Womersley 1987, King 1981). These are subjected to extensive salinity variation from freshwater to full seawater (0-40%). However no phaeophytes have been observed in a fully freshwater habitat in Australia (Entwisle 1994) or anywhere else in the southern hemisphere although several genera are known in the northern hemisphere (Bourrelly 1968). The crustose species *Heribaudiella fluviatilis* (Areschoug) Svedelius of the Lithodermataceae is widely distributed in freshwater streams of the northern hemisphere (Yoshiaki *et al.*1984, Wehr and Stein 1985, West 1990). Among the filamentous genera of the Ectocarpaceae *Bodanella* is recorded from Lake Constance, Switzerland and *Pleurocladia* is known from several localities in Scandinavia, Germany and France. Thus far *Ectocarpus* is unknown in truly freshwater habitats although it sometimes occurs in the saltwater intrusions of rivers in Germany (D. Müller, personal communication).

Materials and methods

The collection data are as follows: 24 March 1995. Hopkins River Falls, (38°20'S, 142°37'E) Victoria (Fig. 1) . This is a 15 meter high water fall about 25 km from the river mouth at Warnambool and about 40 m above sea level. *Ectocarpus* was growing with the red alga *Caloglossa leprieurii* (Montagne) J.Agardh and various green algae including *Mougeotia* and *Cladophora* between the cracks in the basalt rock river bed at the top of the falls. The few filaments of *Ectocarpus* available in the collection were non-reproductive. Water temperature was 16°C. Irradiance at 6:00 p.m. was 1500-1600 µmol m^{-2} s^{-1} as measured by a Li-Cor Radiometer (Model LI-189) equipped with a flathead quantum sensor. Salinity was 1.0 ppt as measured by a Reichert Automatic Temperature Compensated Hand Refractometer (Model 10419). Conductivity was 3.0 mS s^{-1} as measured by a Hanna Portable Conductivity Meter (Model HI 8733).

Living material was placed in a 120 ml screw cap polyethylene sample cup in a cool chest for two days before transport to the university and then held in a plant growth cabinet (Percival I-30 LL) at 15°C, 12:12 LD photoperiod in 10 µmol m^{-2} s^{-1} coolwhite fluorescent lighting for several days. During this time plurilocular sporangia developed and released many spores which germinated to form small thalli that were then isolated into separate containers. Stocks were maintained in stationary (not aerated

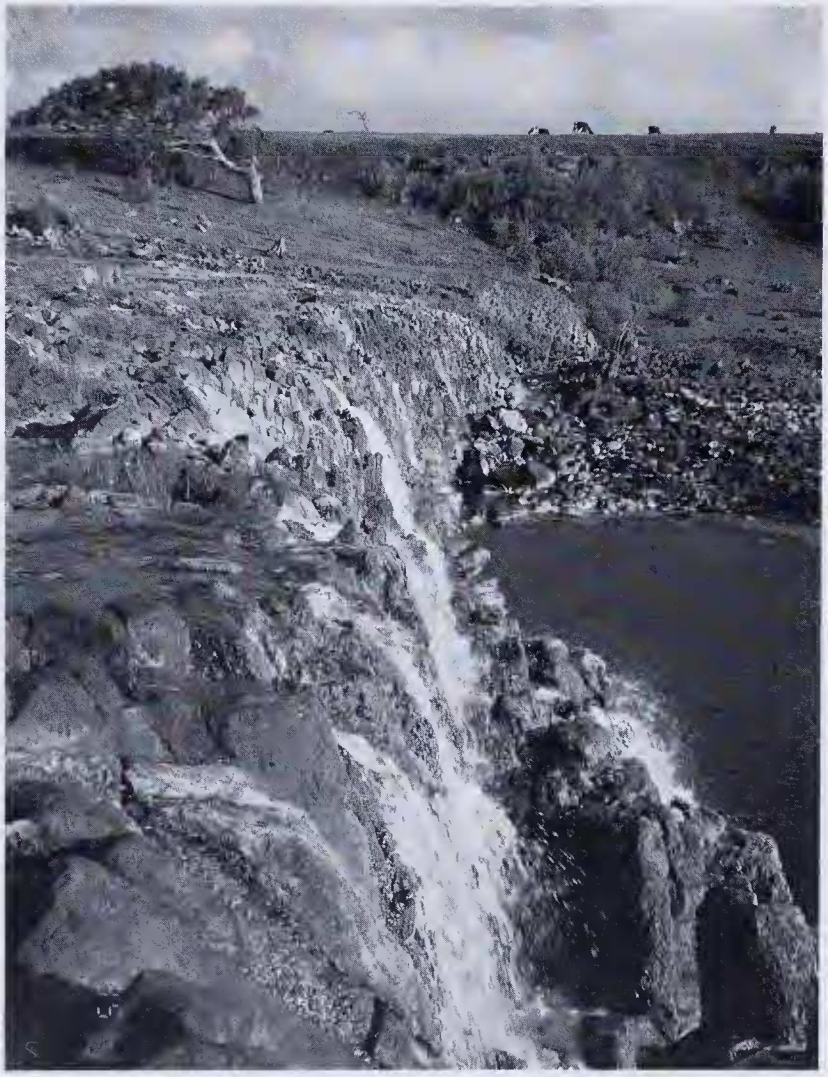

Fig. 1. Habitat of *Ectocarpus siliculosus* at Hopkins River Falls, Victoria.

or agitated) cultures of 5 ppt seawater [Provasoli Enriched Seawater-(PES/2 with 10 ml enrichment per liter) - see Starr and Zeikus 1993] in 300 ml Pyrex No. 3250 deep storage dishes at 15°C, 12:12 LD photoperiod in 15 µmol m^{-2} s^{-1}. Experimental cultures were placed in 100 ml Pyrex No. 3140 dishes with 5, 15 and 30 ppt seawater (PES/2) in 15°C on a 75 rpm New Brunswick Gyrotory Model G-2 shaker at 15µmol m^{-2} s^{-1} coolwhite fluorescent lighting, 12:12 LD photoperiod for 15 days to determine the growth and reproduction. Additional experiments were undertaken in 20 and 25°C at 15µmol m^{-2} s^{-1}, in stationary culture to determine any changes in growth and reproduction.

Cultured specimens are available from the first author. Voucher herbarium specimens of cultured thalli are deposited with the National Herbarium of Victoria (MEL 2025930).

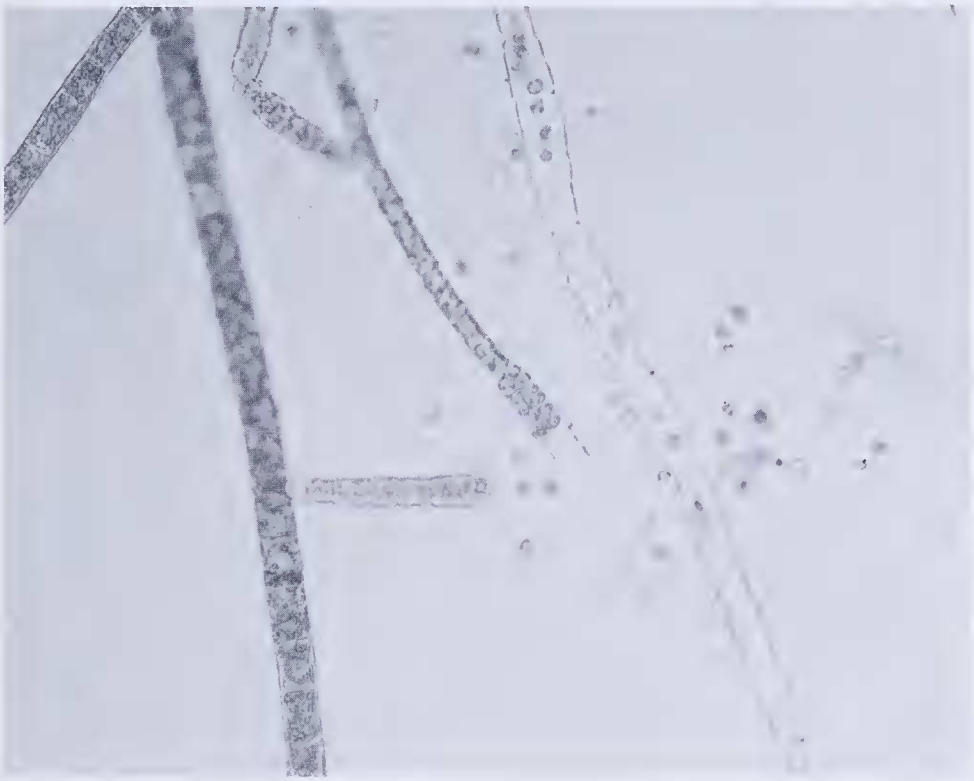

Fig. 2. Sporangia of *Ectocarpus siliculosus* growing in culture.

Results

Growth and reproduction in culture (Fig. 2) were satisfactory in all the water motion, irradiance, temperature and salinity conditions tested indicating that the population from Hopkins Falls is still adapted to a wide range of conditions comparable to those in different field conditions where fully marine populations occur. Spores from the plurilocular sporangia germinated readily in all conditions giving rise to new sporophyte plants that also formed plurilocular mitosporangia. Unilocular meiosporangia were not observed under any conditions tested here. The development from the initial spore germination to fully mature reproductive sporophyte requires only 3-4 weeks in all conditions used here.

The general characters of the thallus appear to change little in culture as indicated in Table 1.

Discussion

Although many other *Ectocarpus* species are known elsewhere only two, viz. *E.siliculosus* (Dillwyn) Lyngbye and *E.fasciculatus* Harvey, are recognized from Southern Australia (Womersley 1987). The primary character used in distinguishing the two species is the scattered elongate plurilocular sporangia of *E.siliculosus* and the

clustered ovoid plurilocular sporangia of *E.fasciculatus*. Müller (personal communication) cautions that the sporophyte morphology is not always reliable in separating the two species and he 'gives species assignment only in cases where he has the full life history in culture'. Müller and Eichenberger (1994) also rely on the presence of the betaine lipid DGTA (diacyldiglycerylhydroxymethyl-trimethyl-ß-alanine) in *E.fasciculatus* and its absence in *E.siliculosus*. Crossing experiments between the two species were also not successful (Müller and Eichenberger 1995) indicating that the two species are genetically incompatible.

As indicated in Table 1 there are minor differences in the morphology between field-collected and laboratory-cultured specimens but these are not sufficient to question the species identification because these characters, particularly filament diameter and sporangial shape and size do change somewhat in laboratory culture because of the changes in water motion, irradiance and salinity levels. It is possible that a lower temperature of 10°C may be sufficient to stimulate unilocular meiosporangial development as is needed for the marine populations of *Ectocarpus siliculosus* from Europe (Müller 1967).

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TABLE 1. COMPARISON OF CHARACTERS OF *ECTOCARPUS SILICULOSUS* IN FIELD AND CULTURE .

Character	**Field** (Womersley 1987)	**Culture**
habitat	epiphytic, epilithic	not applicable
thallus length	1-15 cm	1-12 cm
meristem	intercalary, diffuse	intercalary, diffuse
branching	irregular throughout	sparse to irregular
filament diameter (µm)	20-40	15-24
terminal false hairs	present	present
diameter (µm)	8-12	9-10
plurilocular sporangia		
shape	elongate-conical to narrow linear	narrow linear
length (µm)	70-160	190-570
diameter (µm)	20-35	15-21
terminal false hair	5-10 cells	5-8 cells
chloroplasts	several elongate, lobed and parietal, each with several pyrenoids	several elongate, lobed and parietal, each with several pyrenoids

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